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Modelling Fungal Fermentations For Enzyme Production

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Abstract: We have developed a process model of fungal fed-batch fermentations for enzyme production. In these processes, oxygen transfer rate is limiting and controls the substrate feeding rate. The model has been shown to describe cultivations of both *Aspergillus oryzae* and *Trichoderma reesei* strains in 550L stirred tank pilot plant reactors well. For each strain, 8 biological parameters are needed as well as a correlation of viscosity, as viscosity has a major influence on oxygen transfer. The parameters were measured averages of at least 9 batches for each strain. The model is successfully able to cover a wide range of process conditions (0.3-2 vvm of aeration, 0.2-10.0 kW/m³ of specific agitation power input, and 0.1-1.3 barg head space pressure). Uncertainty and sensitivity analysis have shown that the uncertainty of the model is mainly due to difficulties surrounding the estimation of the biological parameters and to a lesser degree the uncertainty of the viscosity and mass transfer correlations. Until now, the model has been applied to evaluation of energy efficiency at different process conditions and bioreactor designs. Our goal is to expand the model to cover both pilot plant and production scale so that the model may assist downscaling operations as well as production optimization and production planning. Further developments of the model will enable more advanced applications such as model based control and simulated process optimization.

Keywords: process model, model based control, uncertainty analysis, sensitivity analysis, *Aspergillus oryzae*, *Trichoderma reesei*, pilot plant bioreactor, oxygen transfer, rheology
